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# The QUARTERLY REVIEW

Published by the

## American Electro-Platers' Society

A SOCIETY FOR THE ADVANCEMENT
OF THE
SCIENCE OF ELECTROPLATING

JULY, 1933

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QUARTERLY REVIEW
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VOL. XIX JULY, 1933 No. 11

## *Important Announcement*

**We are pleased to inform our readers that the Review will be published monthly beginning with the September number which will also carry advertising to help defray the printing and mailing expenses.**

**There will be no August issue.**

**We want to make the Review more helpful and interesting. Send in your suggestions. They will receive careful consideration. We will be pleased also to publish papers and answer questions submitted by our readers.**

## EDITORIAL

### *The Chicago Convention*

The twenty-first annual convention of the American Electro-Platers' Society was held in the Congress Hotel at Chicago, June 27-30. The local branch did everything possible to make the meetings successful and at the closing business session, Mr. George Hogaboom expressed the feeling of all present when he said "it was one of the best conventions in the history of the organization". Although the attendance was not the largest, it made up in earnestness and enthusiasm what it lacked in numbers and everyone present had a great time.

The papers read at the educational sessions were particularly good. The discussions following the reading of the papers showed

the interest manifested by the assembled delegates who, despite the intense heat, enabled the meetings to start on time by their prompt attendance when the gavel struck the desk, and remained until the chairman declared the meeting adjourned. One thing was particularly noticeable, all through the meetings—a feeling of optimism. Last year in Philadelphia gloom was manifest everywhere, but not so in Chicago this year. "Happy days are here again" seemed to be the theme song of the Convention and a jolly gathering representing practically all the branches attended the meetings, enjoyed the fun, accepted their responsibilities and went home satisfied.

Two items of major importance were introduced at the final session on Friday, the Monthly Review and the Research work at the Bureau of Standards.

After the president had called for the report of the publication committee, regarding the Review and after the discussion of the same by a number of representative delegates from the various branches, it was voted with little opposition to return to publishing the Review Monthly instead of quarterly as at present, and to make the Review self-supporting, by means of paid advertising. It was voted to continue our Research work at the Bureau under Dr. Blum, with Mr. Strausser continuing as our associate.

All the officers were unanimously reelected. Past president Walter S. Barrows was declared winner of the award for his paper "Finishing Steel Products by the Use of Sand, Soap Suds, and Steel Balls" as published in the April, 1933, Review. The new president of Chicago Branch, Mr. E. G. Stenberg, received the exhibit award. Both awards were presented by Mr. Hogaboom who congratulated the winners heartily on behalf of their efforts for the benefit of the Society.

Detroit was chosen unanimously as the place of meeting for the 1934 Convention.

Past president Walter Fraine installed the reelected officers and President Van Derau then declared the Convention adjourned.

## CHICAGO
## THE CONVENTION—THE EXPOSITION

I. The artists' display across from the hotel was quite an attraction. Many of those admiring the works of art wore A. E. S. badges. Some of the pictures wore less than that.

II. Dan Wittig of Milwaukee Branch has a cheery word for everyone. It is because of such members as Dan we like to be linked up with the A. E. S.

III. After all we are loyal to one another. We have differences of opinion and express ourselves openly on the Convention floor, but we carry no grudges. Colonel Hansjosten has a big heart. We thank him for his promised assistance, we will need it.

IV. We missed Past President George Gehling, who is ill in Frankford Hospital in Philadelphia. George has been one of the society's staunchest supporters. Everyone wishes him a speedy recovery.

V. There was little opposition to the officers being reelected. Mr. Van Derau has worked hard during the past year especially in financing the Research. Van never spares himself. This society of ours has had many splendid men in the president's chair. Van is no exception. We wish him every success for the coming year.

VI. Mr. Gilbertson and the other Chicago Branch members were kept on the jump during the Convention. The ladies committee also deserve a lot of praise. All in all we were pleased with the arrangements, the courtesies extended and the kindly spirit back of it all which makes our visit to Chicago one long to be remembered with a great deal of pleasure.

VII. Los Angeles and San Francisco Branches had representatives at the Convention. We were glad to greet them.

VIII. We wish we had more time to spend at the Century of Progress Exposition. It is wonderful, educational, and inspiring. If any of our readers who have not seen it can get to Chicago before Nov. 1st and spend a week at the exposition they will not be sorry.

IX. Give us your support and cooperation. Send us suggestions to better the Review. Branch secretaries send your reports in monthly. Let's all work together for the common good!

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## METAL FINISHING OF ELECTRIC IRONS

**By Clarence L. Van Derau**
Superintendent, Westinghouse Electric and Manufacturing Co., Mansfield, Ohio
*Reprinted from December, 1932 issue of* METALS & ALLOYS

Ordinary household irons, although created and devised for strictly useful purposes, are undergoing many changes, and of these changes, style is probably one of the greatest. It seems a

far cry from the metal industry to style trends and modes, but the manufacturers have found that women appreciate beauty in irons as well as in clothes and other accessories. Industry in the past has been slow to realize this and the improvements made on the household appliances were, in the main, generally of a scientific nature. An iron was simply an iron—an object of use—and very little concern was given to its appearance.

However, "the old order yieldeth to the new" and now we have beautiful gleaming irons that are a credit to any production put out by manufacturers for practicability as well as beauty. This change in appearance has been made largely by the improved processes in metal finishing and the increased efficiency of automatic finishing equipment. The development of machines and the standardization of processes and material have changed the problem of manufacturing irons from an art to a science with the result that a high quality finish demanded by the public has been reduced to a minimum cost.

The parts requiring finish on the electric iron consist of a cast iron base, a cold rolled steel cover, front and rear handle straps, heel rests, rivets and handle bolts.

The first operation in finishing the iron base is to grind 0.015 inches of material from the top of the base to provide a flat surface for the element and cover on a specially built circular grinding machine. The machine is loaded and unloaded by one operator and the bases pass under four wheels, 9 to 14 inches in diameter, by 5½ inch faces and 1¾ inch arbors; one 10 grit, one 24 grit, one 36 grit and one 60 grit. The maximum production of the machine is 30 pieces per minute.

From this operation the bases pass over a conveyor to a special drilling and tapping machine, which drills and taps eight holes at one time and has a maximum capacity of 10 parts per minute. The machine is equipped with a cam operated fixture which is manually loaded and automatically unloaded.

The drilling and tapping operation required considerable development as it was necessary to drill and tap a hole in the iron bases that would have 4 full threads, and not drill through the bases which is less than ½ inch in thickness. High speed steel taps with practically no lead were found satisfactory for the operation. It was necessary for the foundry to reduce their tumbling operations to a minimum to prevent dubbing off of points as this would cause irregular location of bases in the

drilling and tapping fixtures. This, in turn, would have made it impossible to automatically grind edges of castings accurately, as the succeeding operations are located from pins that fit in drilled and tapped holes of the iron bases. Next the base is dropped on a belt and is conveyed to tote boxes on gravity conveyor lines which deliver them to a battery of disc grinding machines. These machines are equipped with special rotating fixtures which are cam actuated and are capable of grinding 3 different radii on each side of the iron base at a 58° angle with bases located over pins in drilled and tapped holes. The fixtures also oscillate front to back in order to give even wear on the grinding disc face. The first 2 grinders are right and left hand and the disc used is 12 grit, 30 inches in diameter, ¼ inch thick, with an 8 inch opening in the center.

It required a period of almost two years to secure a grinding disc that would grind edges satisfactorily and economically. The first disc used would turn out approximately 500 iron bases, then due to the wearing off of rough surfaces of the disc, and the heat generated, discs would come loose from the steel mounting plate. This was overcome by having the supplier perforate the disc while in the unvitrified state. These perforations had the appearance of a baked waffle and provided space in the disc for iron and abrasive dust. That, in turn, was thrown out by centrifugal force of the rotating disc, after leaving the point of contact of the iron base to the disc, and overcame the abnormal heating of the disc, making it possible to grind from ten to fifteen thousand iron bases on a single disc.

It was also found that it was not practical to grind more than 10 bases per minute as the higher speed would cause small cracks in the edge of iron base, any where from 1/16 to ½ inch in length, that did not show up until the final operation of plating and buffing. These cracks, having the appearance of fine hair lines, were caused by the abnormal heating up of the edge of the iron bases during the grinding operation, and were particularly troublesome on hard chilled castings. It was necessary to have the foundry regulate the time of shaking out the castings from their sand molds to overcome the irregular chilled surfaces of castings. The bases then pass to another right and left hand machine for fine grinding to reduce time of final hand polishing operation on edges. On this machine a 120 grit disc, 30 inches in diameter, ¼ of an inch thick, having an 8 inch center

opening is used. Grease stick is used as a polishing lubricant on this disc. The production of these machines is 10 iron bases per minute and from 0.025 to 0.035 inches of iron is removed from the edge on the two grinding operations.

The next operation on the iron base is to grind the back on an 18 inch disc grinding machine which has a special holding fixture. The irons are conveyed from one machine to the other by gravity conveyors throughout all grinding operations. From the grinding operations the base goes to a three station boring machine where the thermostat hole is drilled and counter bored.

The irons are then loaded on a booster and delivered to the loading end of a base bottom grinding machine of the 10 wheel tandem type which has a capacity of 30 pieces per minute. Each grinding or polishing wheel is driven by its own individual motor of from 7½ to 10 horsepower. The pressure and amount of cut of the wheel on the iron base is regulated by spring tension and individual ammeters connected to each motor. The iron bases are loaded on an 8 inch belt equipped with jig attachments and pass under four 10 grit wheels, two 24 grit wheels, two 36 grit wheels and two 60 grit wheels. The wheels are of silicon carbide and bakelite types, and range in size from 14 inches to 9 inches in diameter. They have a 5½ inch face and a 1¾ inch arbor hole. This grinding operation removes from .025 to .035 inches of cast iron from the bottom of the iron bases.

Several thousand dollars was spent in developing grinding and polishing wheels for this machine for grinding and polishing iron bases. Machine pressed 10-24 and 36 grit wheels were found very unsatisfactory, and it was necessary for the supplier to make up wheels in which sawdust was mixed with the abrasive and bond and then hand puddled to prevent getting a wheel that was too compact. This type of wheel is very porous after the firing operation, as the sawdust burns out, leaving the wheel in a honey-combed condition; thereby permitting air to circulate through the wheel and overcome the abnormal heating and breaking of grinding wheels. This also overcomes the tendency for grinding wheels to glaze over as the iron and abrasive dust is pressed into the recesses of the wheel, which, in turn, is thrown out by centrifugal force after leaving point of contact of wheel and iron base. The 60 grit Bakelite type of wheel proved far superior to the silicon carbide type of wheel as it left a much finer abrasive mark in the iron casting and did not heat up as much as the silicon carbide type, although it was more expensive.

It was necessary to standardize the grades of the various grit wheels to a range of from K to P of the Norton Company's standard for hardness of wheels. The heating of wheels encountered on this machine is caused by the almost continuous grinding operation; whereas a hand operator is generally off his wheel as much time as he is grinding on the wheel. This idle time permits air cooling of his grinding wheel and is a problem to deal with on almost all continuous automatic grinding machines when using the dry process of grinding.

After the grinding operation the bases are loaded in tote boxes and conveyed around the back of the machine to the loading end. This provides for storage and necessary cooling time between grinding and polishing operations. The wheels are then changed from grinding to compressed canvas polishing wheels which are 16 inches in diameter, 5½ inch face and are set up with emery and glue ranging from 80 grit to 160 grit. Fast cutting artificial grit is used on 80 and 120 grit wheels. The 140 and 160 grits are of the dull cutting Turkish emery, as a fast cutting fine emery required excess buffing to cover wheel marks that would show through in the final buffed iron bases.

Grease stick and 180 grit emery cake are used as polishing compounds. The conveyor belt on the machine is equipped with oscillating fixtures to break up grinding and polishing abrasive marks. After this polishing operation the bases are loaded into tote boxes and conveyed by gravity to the hand polishers who finish the sides and remove sharp edges at the junction of the side and bottom of the base. These operations are performed on compressed canvas wheels set up with 120 to 160 grit emery. The bases are delivered from the hand polishers over gravity conveyors to an inspection station where they are gaged and inspected for defects prior to plating.

Disc type of muslin or canvas polishing wheels were found very unsatisfactory as every ply or section of disc type wheel would show up in the finished iron base, giving the appearance of hills and valleys. It was found that the compressed canvas type of polishing wheel will remove this defect as the polishing is done on the flat side of the canvas cloth instead of the edges. It was found that the ordinary compressed canvas wheel with side plates on each side, that are commonly used on hand polishing operations or slower types of polishing machines with wheels of smaller width, were not strong enough to stand up in

service on this machine, as the wheels would assume a concaved position when in contact with the iron base under the heavy spring pressure, and after leaving the point of contact, it would assume a convexed position, causing the irons to come off the machine with convexed and concaved surfaces. It would also cause the glued segments of the wheel to separate and throw themselves out of the steel retaining plates by centrifugal force. This trouble was overcome by having the supplier of this type of wheel reinforce the center face of the wheel with two additional steel plates. This reinforcement made the wheels cost three times as much, but proved to be more economical as they will last several years in service, against a few hours for the standard type.

The physical and chemical tests for the iron base castings worked to by the foundry are:

*Physical*

Transverse 2930 lbs. on 1.253″ diameter bars

*Chemical*

| | |
|---|---|
| Silicon | 2.46 |
| Sulphur | .082 |
| Phosphorus | .53 |
| Manganese | .57 |
| Carbon | .48 |
| Graphitic Carbon | 3.09 |
| Total Carbon | 3.57 |

The covers which are made of deep drawing, cold rolled steel are of the following physical characteristics:

Olsen .440–.460
Rockwell B 50–B 55
Elongation on 5″ long, ¾″ wide—Straight specimen
Longitudinal Minimum 28%
Transverse Minimum 24%

They are first blanked in a die and then formed in a 100 ton draw press. In one operation this press runs at a speed of 20 strokes per minute and is equipped with air cushions and a delivery conveyor belt that takes the covers to the trimming press. The covers are trimmed in a shimmy die. After the trimming operation, handle strap and clamping bolt holes are pierced and heat graduations for the thermostat control are stencilled in a compound die. Then the covers are loaded into tote boxes and delivered by conveyor to hand polishers who polish them on a compressed canvas wheel set up with 160 Turkish emery and glue. They are then brushed on a circular tampico brush using

180 emery cake as a polishing compound in order to remove abrasive scratches. After polishing, the covers are delivered by gravity conveyor to an inspection station where they are inspected for material and polishing defects prior to the plating operation.

As there is always one side of a sheet of cold rolled steel more free from pits and material defects than the other side of the steel, sheets of steel are inspected by the incoming raw material inspector and striped, using a tube approximately 10 inches long, ½ inch in diameter, with a felt cork inserted in lower end and regular cork in top which is filled with a dye solution made up to the following formula:

| | |
|---|---|
| Lacquer Thinner | 75% |
| Clear Lacquer | 15% |
| Aniline Dye | 10% |

Various colors indicate the different suppliers, leaving red aniline color as a mark on questionable steel. This stripe is put on by the incoming raw material inspector by simply drawing his tube of dye from end to end on the selected good side of the steel. This mark indicates to the press operators the proper side to throw blanking burs and makes it possible to always turn the good side of the steel out where the final high finish is required, and has made it possible, with the aid of careful handling in the press shop, to reduce polishing operations from three wheels to one wheel, and has increased production from 30 pieces per hour to approximately 100 pieces per hour in the polishing operation.

All polishing and grinding wheels used in the preceding finishing operations come from a laboratory controlled glue room equipped with special truing and cleaning machines. 80 pounds of high pressure steam and centrifugal force is used to clean off old heads of glue and emery prior to re-setting wheels with glue and emery.

This method of cleaning, dressing and setting up of polishing wheels has proven very economical as very few polishing wheels are worn out by the polishing operation, but are worn out by the polisher using a file or piece of pipe to remove old heads of emery, glue and polishing grease that penetrate into the fabric of wheel. No polisher can clean a wheel using this method without removing some of the fabric and consequently the working face becomes smaller in diameter and goes to the scrap pile pre-

maturely. However, if high pressure steam is not available, the steam cleaning of wheels will not be satisfactory as low pressure steam contains too large an amount of water and will cause the glued segments or plies of cloth to come apart.

A speed of 2200 r.p.m. has proven satisfactory for wheels ranging in size from 10 inches to 16 inches in diameter. The speed should be increased for wheels of smaller diameter in order to throw off glue, emery and greases to prevent penetration into glued sections of wheels.

Wheels cleaned by the above methods will last from five to ten years in service as against a few weeks or months when set up by the polisher.

Glues ranging in price from $.15 to .30 per pound have been tried out on automatic polishing machines and it is more economical to use a high grade hide and sinew glue, as we have found that on the iron bases as high as 16 wheels set up with cheap glue were required; whereas, from three to five wheels were required to do the same given amount of work using the better grade of glue.

The glue is soaked in a definite amount of water (8 lbs. glue to 11 lbs. of water) for approximately 15 hours after which it is heated in a jacketed steam cooker where it is dissolved and flows into a thermostatically controlled steam heated reservoir at a temperature of 180° F. From this reservoir, glue is drawn off into quart containers and placed in a thermostatically controlled hot water table at a temperature of 170° F. Individual cans of glue and brushes are provided for each of the various grades of emery used. The emery containers are steam heated to eliminate the possibility of the glue being chilled by cold emery.

Large wheels used on automatic polishing machines are set up on a wheel setting machine and all wheels are allowed to dry for a period of not less than 12 hours before using. For difficult polishing operations the wheels are dried in an oven at a temperature of 180° F. for a period of at least 12 hours.

Handle straps and heel rests are made of cold rolled steel in cam actuated dies. They are then delivered by conveyor to the plating department where they are burnished in hard maple lined steel burnishing barrels. The barrels are loaded with parts, together with ⅛ inch steel balls and 3 pounds of neutral soap, and burnished for a period of 12 hours.

All of the various parts to be plated, including the polished bases and covers, and the burnished handle straps and heel rests are racked on their respective racks. They are then cleaned in an emulsified soap solution which is as follows:

| | |
|---|---|
| Tri Sodium Phosphate | 1.5 oz. |
| Caustic Soda | 1.5 " |
| Soda Ash | .9 " |
| Sodium Metasilicate | .84 " |
| Bentonite Clay | .06 " |
| Fatty Acid as Soap | .9 " |
| Rosin | .3 " |
| Total | 6 Oz. |
| Water | 1 Gal. |

then given a water rinse and electro-cleaned in an alkaline copper cleaner of the following formula, using 6 volts, direct current for approximately 1 minute:

| | |
|---|---|
| Tri Sodium Phosphate | 2 oz. |
| Soda Ash | 1.4 " |
| Caustic Soda | .56 " |
| Powdered Rosin | .02 " |
| Bentonite Clay | .02 " |
| Sodium Cyanide | 1 " |
| Copper Cyanide | .5 " |
| Water | 1 Gal. |

and rinsed in water and placed in the moving cathode nickel plating tanks where they are allowed to remain until a deposit of .001 inches of nickel is obtained. (This generally requires 1 hour to 1 hour and 15 minutes of time.)

The current density for nickel plating averages 12 amps./ft$^2$ at 3½ volts. The formula for the nickel solution is:

| | |
|---|---|
| Nickel Ammonium Sulphate | 10 Oz. |
| Nickel Sulphate | 10 " |
| Sodium Chloride | 4 " |
| Boracic Acid | 4 " |
| Magnesium Sulphate | 4 " |
| Water | 1 Gal. |

The plating processes are laboratory controlled in order to maintain a soft deposit free from pitting and peeling defects suitable for easy buffing and adherent enough to stand up under stencilling operations that are put on the iron cover in the finished state.

The factors of the nickel solution that require accurate control are:

| *Factors* | *Value* | *Analysis* |
|---|---|---|
| Ph | Daily | 6.2 to 6.4 |
| Nickel Content | 3.56 Oz. | Weekly |
| Chlorides | 3.5 to 4 Oz. | Weekly |
| Boric Acid | 3.5 to 4 Oz. | Weekly |
| Magnesium Sulphate | 4 Oz. | Weekly |
| Water | 1 Gal. | |

All plating factors such as current density, plating time and temperatures are standardized and placed on master route sheets and in process specifications that covers the operators activities.

A new nickel solution made to the above formula will have a pH of 5.6 to 5.7 and requires ammonia to raise the pH from 6.2 to 6.4, after which a small addition of 30% Hydrogen Peroxide is used daily to maintain an operating pH of 6.2 to 6.4. By accurate controlling the pH values of the nickel solutions daily, it is possible to practically eliminate all pitting and peeling of nickel deposits. The other factors of a nickel solution are not as sensitive and only require weekly analysis and additions of chemicals to bring them back to their original formulas.

99% rolled depolarized nickel anodes are used as a source for replenishing the metallic nickel content of the plating solutions, and even though the depolarized anodes cost approximately 2¢ more per pound, they have proven themselves to be more economical as it is only necessary to filter the plating solutions twice a year as against filtering monthly when using the other types of anodes.

This means a saving of approximately $4,000.00 on lost solution and filtering labor on eight 1700 gallon tanks per year in addition to a saving not estimated in excess buffing compounds and labor and rejections that would be caused by floating particles of dirt in the plating solution that would settle out of the solution on all parts that would form a shelf or ledge.

After plating, the racked parts are rinsed in cold and hot water and then placed on an unloading conveyor. The plated polished parts are unracked and placed in tote boxes and sent to the buffing department on gravity conveyors where covers are buffed by hand on buffing lathes running at 3400 r.p.m., using 7 sections of 16 inch diameter, 30 ply, ¼ inch sewed muslin buffs. These buffs are discarded from the cover buffing operation when they reach a diameter of 10 inches as a peripheral speed changes from 14,200 to 8,700, and these smaller sections of buffs can be used on other lines of apparatus.

Bevelled iron base edges are buffed by hand on one side of a d.c. buffing lathe with a selective r.p.m. speed of 1600 to 2400, while the bottom of another base is being buffed on an oscillating type, automatic buffing machine placed on the other side of the lathe and operated by the edge buffing operator.

A combination of loose and sewed buff sections is used on this operation being of the same diameter and used down to the same size as the buff sections used on iron covers. A lower speed lathe was found more desirable as it overcame the tendency to cut through the iron base edges and produces a superior finish on the bottom of the base.

Lime buffing compound is used for buffing and coloring of nickel. The buffed parts are inspected, packed in tote boxes and sent by gravity conveyor to the chromium plating machine. The handle straps and heel rests are unracked and placed in burnishing barrels where they are burnished for one hour to bring out a luster of the nickel. These parts are then sent to the chromium plating machine.

All parts are racked on special racks for chromium plating and are plated on an automatic chromium plating machine. The machine consists of a rotary conveyor with cam operated lifts through a series of tanks. The loading and unloading of the machine takes place at one station requiring one operator.

Parts travel through an alkaline electro cleaner operated at room temperature, a water shower and rinse, and another water shower before entering the chromium solution. After a 3 minute chromium plating period and 2 successive water rinses and a final cold water spray, parts pass through a hot air drying tunnel for approximately 3 minutes. The final rinsing of parts through a cold water shower overcomes water stains on the plated parts.

The parts are then unracked, inspected, packed in tote boxes and dispatched by conveyor to the assembly conveyor.

The cleaner used for chromium plating is of the following formula:

| | |
|---|---|
| Sodium Metasilicate | 2 Oz. |
| Water | 1 Gal. |

The reason it is run at room temperature is to prevent staining of clean parts when passing out of the electro cleaner into the first water shower, due to the iron base castings absorbing heat, causing the cleaner to dry off during time of transfer.

The formula for chromium solution is:

| | |
|---|---|
| Chromic Acid | 40 oz. |
| Sulphuric Acid | .40 Oz. |
| Water | 1 Gal. |

The operating temperature is 135° F. and the current density is approximately 300 amps./ft.$^2$. The chromic acid and sulphuric acid content is checked weekly by the chemical laboratory and additions of these 2 ingredients are always governed by chemical analysis.

Iron elements, cords and thermostats are made in their respective detailed assembly groups, feeding up to the main assembly conveyor where they join up with the plated parts for assembly. After assembly they are given a heat test, after which they pass through a cooling tunnel. Irons are removed from the cooling tunnel conveyor and receive a final buffing operation on loose cotton buffs to remove all stains and marks due to handling. After this operation they are placed in their respective cartons and delivered by conveyor to the warehouse.

## THE MANUFACTURE OF PORCELAIN OR VITREOUS ENAMEL ON SHEET IRON

**By Glenn A. Hutt, Ceramic Engineer**
Manufacturing Division, Frigidaire Corp., Dayton, Ohio
**Lecture Delivered to Anderson Branch, March 6, 1933**

*History*

Porcelain or Vitreous enameling is not a new subject. Glasses, glazes, pottery, bricks, tiles and enamels are all closely related, and we find all were being made many hundreds of years before the birth of Christ.

There is no authority on which to base facts concerning the actual origin of enameling. Some authorities give Western Asia as the place of origin, but most conservative authorities insist the question is open due to the small amount of evidence available.

Some of the finest work of the ancients was not on metal but upon pottery, tile and brick. The ancient Egyptians and Assyrians achieved their greatest work in this type of enameling.

The Chinese are credited with making pottery as early as 2000 B.C. The date of discovery of glass is not known. Works in glass have been found in Egypt, Phoenicia and India. The Greeks and Romans in the 4th and 5th Centuries B.C. enameled

jewelry and art objects. The metals used were gold, silver, bronze and copper. The Romans spread the art in their conquest of England almost 2000 years ago. So it spread to Ireland, France, Russia and Spain.

Beginning the 19th century, the Germans used enamel for the interior of kitchen ware. Later in 1839, a patent was issued in England for enamel on cooking utensils. By 1850, the English started using enamel on bath tubs to replace paint and varnish.

In 1867, a plant in New York started enameling cooking utensils and at about the same time the Volrath plant in Wisconsin followed. Kohler Company of Wisconsin was the first to enamel bath tubs and Moore Bros. in Illinois enameled stoves starting around 1890. Next followed refrigerators, wash tubs, etc.

Up to the present time we find numerous pieces and articles being porcelain enameled. These include signs, roofing tile, tank cars for mild, grave vaults, houses and many others. Much time could be devoted to the history of enameling. The ancients proved two things: (1) That it is beautiful, and (2) The hundreds and thousands of years which their works have endured proves its durability.

*Definition of Porcelain or Vitreous Enamel and Enamel*

There is at the present time some difference in the nomenclature of Porcelain, Porcelain Enamels, Vitreous Enamels and Enamels. We can think of Porcelain Enamels and Vitreous Enamels as the same. Porcelain or Vitreous Enamels can be defined as a proper mixture of chemicals which are melted together giving a glassy mass. This mass is quenched in cold water, then ground and applied to the metal in one or more coatings. These coatings are fused on the metal at a dull red heat of temperature varying from 1500 to 1600 degrees Fahrenheit.

In paint enamels there is no fusing but merely a baking to the metal, and no temperature over several hundred degrees Fahrenheit attained. Some paints are not even baked to the metal but merely dried.

*Metal*

At the present time we have porcelain enamels being applied on copper, gold, cast iron and sheet iron. We will discuss those processes used in the manufacture of porcelain enamels on sheet iron in this paper.

Armco Ingot Iron is a typical enameling sheet and has the following approximate chemical composition:

| | | |
|---|---|---|
| | Fe | 99.85% |
| Cu, Mn, C, And others | $SiO_2$, P, S | .15% |

*Forming*

The metal is received in sheets in the following thicknesses:

| *Gauge* | *Thickness in inches* |
|---|---|
| 12 | .109 |
| 16 | .063 |
| 18 | .050 |
| 20 | .037 |
| 24 | .025 |

The sheets are sent to the punch press department and are sheared, formed, pierced, welded, drawn, and sand blasted according to the operation or operations necessary to make the required piece.

*Pickling*

After forming, the piece is pickled. Pickling is the cleaning of dirt, shop grease, protective oils and scale from the metal, and a slight etching of the surface of the metal. No piece can be perfectly porcelained enameled without good pickling.

Pickling can be divided into 6 operations as follows:

| | | | |
|---|---|---|---|
| 1. Cleaner | Tri-sodium Phosphate, Rosin, Soda Ash and Sodium Hydroxide | 200° F. | 8 to 10 minutes. |
| 2. Warm Water Rinse | | 150° F. | 2 " |
| 3. Acid 6 to 8% Sulphuric Acid | | 150° F. | 8 to 12 " |
| 4. Running Water Rinse | | 150° F. | 2 " |
| 5. Neutralizer | 90 parts Soda Ash | 150° F. | |
| | 10 parts Borax | | 4 to 6 " |
| 6. Dryer | | 300 to 325° F. | 4 to 6 " |

*Frit Manufacturing*

Frit manufacturing is a very interesting part of porcelain enameling. At the present time only a few companies make their frit, it being purchased from suppliers specializing in this work.

There are four principal types of frit used:

1. Ground Coat Frit.
2. Regular White Frit.
3. Acid Resisting White Frit.
4. Colored Frit.

The following materials make up over 50% of the raw batch weight in making frits:

$$\left.\begin{matrix} Na_2O \\ K_2O \end{matrix}\right\} Al_2O_3 \cdot 6\,SiO_2$$

Feldspar
Silica or Flint ..... $SiO_2$

$$Borax \ldots\ldots\ldots\ldots Na_2B_4O_7 \cdot 10\,H_2O$$

Feldspar is mined in the Carolinas, Delaware, New England States, Canada and the Dakotas. Silica or flint comes from Pennsylvania and Illinois; Borax comes from the Death Valley in California.

Other chemicals used are:

| | | |
|---|---|---|
| Cryolite | $Na_3AlF_6$ | From Greenland |
| Sodium Nitrate | $NaNo_3$ | From Chile |
| Sodium Carbonate | $Na_2CO_3$ | Manufactured |
| Fluorspar | $CaF_2$ | England |
| Zinc Oxide | $ZnO$ | Manufactured |
| Sodium Antimonate | $NaSbO_3$ | From China and Manufactured |
| Antimony Oxide | $Sb_2O_3$ | From China and Manufactured |
| Potassium Carbonate | $K_2CO_3$ | Manufactured |

Chemicals used in Feldspar:

| | | |
|---|---|---|
| Potassium Nitrate | $KNO_3$ | Manufactured |
| Calcium Carbonate | $CaCO_3$ | Plentiful in U. S. |

These chemicals constitute the important items for white and acid resisting frits.

For ground coat frits and black frits, the following chemicals are used also:

| | | |
|---|---|---|
| Cobalt Oxide | $CoO$ and $Co_3O_4$ | From Canada, Norway and Sweden |
| Manganese Oxide | $MnO_2$ | Russia and India |
| Nickel Oxide | $NiO$ and $Ni_2O_3$ | Canada and Pennsylvania |
| Iron Oxide | $Fe_3O_4$ | Mined in U. S. A. and purified |

In making frit the correct proportions of raw materials are weighed and mixed thoroughly. The batch is then introduced thru the roof of a smelter. Smelters have a capacity varying from 100 pounds to 5000 pounds. The maximum temperature reached is around 2250° F. The batch is allowed to remain in the smelter for a certain determined time, then tapped and run into a tank of cold water which shatters the molten glass into small particles called "frit".

In white frits the stannates, the antimonates and the fluorides contribute the whiteness and opaqueness to the frit, wherein, if omitted the resulting frit is a clear glass. For colored frits and enamels the following oxides are used in the raw batch or mill additions:

| | |
|---|---|
| Cadmium Oxide<br>Selenim Oxide | Yellow |
| Chromium Oxide | Green |
| Cobalt Oxide | Blue to Blue Black |
| Iron Oxide | Black to Dark Green |
| Manganese Oxide | Brown, Purple to Black |
| Copper Oxide' | Red, Green to Blues |
| Nickel Oxide | Green, Brown to Blue |
| Titanium Oxide | Brown |

Combination of oxides will give different colors. Smelting atmosphere and burning conditions affect colors.

*Milling*

Milling is the grinding of the glassy frit along with chemicals and water to a fine paste.

The principle materials used in milling are Frit, Vallender clay from Germany, Tin oxide from the Malay Straits, Magnesia oxide, Borax, Feldspar and other chemicals. The materials are weighed out in exact proportions and introduced into large ball mills of capacities of 1000, 2500 and 4000 pounds.

The ball mill is a cylindrical iron shell and lined with porcelain blocks. The mill is approximately half full of porcelain balls, varying in diameter from one inch to three inches.

After the mill has been charged with the materials, water is introduced and the mill started, rotating at 20 to 25 r.p.m. The continual rolling of the balls on each other and on the lining grinds the frit and other material to a desired fineness. This fineness is checked on 150 and 200 mesh screens and in this manner, we can tell when a mill has finished grinding. It takes from 8 to 10 hours to finish a mill to the required fineness. After finishing the enamel is pumped over 40 and 50 mesh vibrating screens into storage tanks where it is held for use.

*Ground Coat Application*

After the metal has been pickled and metal finished, it is ready for its first coat of enamel. This first coat is called the ground coat and burns out to a bluish black. Up to the present time there has been little success applying white enamel direct to the metal. Blue or black ground coats give adherence to the metal when fused, whereas white ground coats do not give this adherence. Cobalt, nickel and manganese give this adherence to the metal, this being the latest theory advanced on ground coat adherence.

The ground coat is applied to the metal in two ways:

1. Dipping.
2. Spraying.

In dipping, the ground coat is placed in a shallow tank of a capacity of 600 to 800 pounds of ground coat. The enamel is adjusted to a fixed density and viscosity so as to give a certain weight of coating when a piece of metal is dipped into the slip, removed and allowed to drain.

In spraying, the same procedure follows as in paint spraying.

The sprayed and dipped pieces are placed on continuous conveyors which pass thru driers of a temperature of 200 to 250 degrees Fahrenheit. This dries the ground coat to the metal with a hard, tough coating and permits easy handling of the piece.

*Furnaces*

Two types of furnaces are used to fuse the enamel to the base metal, (1) Continuous, and (2) Box Type.

A continuous furnace contains a firing chamber approximately 35 feet in length, with pre-heating and cooling chambers. Thru these chambers travels a chain suspended from overhead and on which chain are attached hooks on which to hang the pieces to be burned. This chain is of endless construction and its speed can be regulated to give the desired time to fuse the enamel.

The box type furnace is one with only the heating chamber covered by a door which can be raised and lowered. A traveling fork can be inserted into the firing chamber and withdrawn. On this fork are placed special tools and fixtures on which the pieces to be burned are placed. When the fork is loaded, the door is opened, the fork run in, the tools and fixtures are rested on special refractory blocks in the furnace, the fork withdrawn, the door lowered and the pieces are allowed to remain in the furnace for a certain specified time. The operation is reversed when the burning time is finished.

Heat used on the continuous furnaces is supplied by electricity, gas and oil. Oil is used on box type furnaces at our company.

Box furnaces can accommodate pieces which are large and unable to pass thru the small continuous furnace door openings. Heavy pieces and odd shaped pieces are also burned on box type furnaces.

Special alloys of heat resisting type are used in all furnace construction and for tools and hooks where metal comes in contact with the heating chamber.

*Ground Coat Burning*

The temperatures used for ground coat burning are from 1560 to 1600° F. and the time varies from 4 to 6 minutes.

*White Coat Burning*

The pieces, after the ground coat has been fused, are inspected for defects and then are ready for the first white coat. This white coat is applied by a spray gun at a uniform predetermined weight of coating. The pieces are on a continuous moving chain while being sprayed and this chain carries the ware thru a drier similar to the ground coat drier.

After being dried some shapes require such operations as brushing in which the edges are brushed showing the ground coat. This brushing gives a pleasing appearance and also durability to the edge. These edges are then covered with black porcelain enamel. Screw holes are reamed to reduce the possibility of chipping when inserting the screws.

These pieces are burned in the same fashion as ground coat pieces but at a lower temperature and time. These temperatures vary from 1490 to 1520° F. and times from 2 to 4 minutes. The time and temperature necessary to burn ground coat and white coat pieces are dependent on the type of enamel, size and weight of piece.

The second coat of white enamel is applied the same as the first. The same general procedure follows as the first coat. In most cases the second is burned at a slightly lower temperature.

If the second coat of enamel has any defects such as pits, scale, ground coat reboiling, dirt, etc. it is rejected by inspection. A third light coat of white enamel is applied and reburned.

Acid resisting white enamels are applied in the same manner as regular white enamels. A piece requiring acid resisting enamel is handled the same for the ground coat and first coat of regular white, the second coat being acid resisting over the regular white.

*Conclusion*

For durability, beauty and cleanliness, porcelain enamel has no equal. Every day finds new objects and products adopting this finish. It has no serious competitor.

# pH AND ITS ELECTROMETRIC DETERMINATION

**By Edward B. Sanigar**
Philadelphia Branch
**Read at the Philadelphia Convention, 1932**

## *I. Introduction*

### 1. *Acids and Basis.*

Acids, when they ionize (split up) in aqueous solutions give rise to hydrogen ions, and it is these H–ions which give aqueous solutions of acids their characteristic properties. Similarly, hydroxyl ions are formed by the ionisation of hydroxides, and the characteristic properties of hydroxides are traceable to these OH–ions.

It is possible, by titration or other methods, to determine the amount of acid in a given solution. The result may be stated either as a certain number of grammes of acid per litre of solution, or in terms of normality. Both methods give values referring to the actual concentration of the acid but do not give any information about the actual *strength* of the acid.

If 0.1 *N* solution of hydrochloric acid and boric acid are titrated under suitable conditions their equivalent acidities will be found to be equal, since each contains that amount of acid which is equivalent to 0.1 gr. of hydrogen. However, hydrochloric acid is a much stronger acid than is boric acid, due to its greater percentage splitting up (degree of ionisation) in solution. Consequently, although the total amount of hydrogen is the same in the two solutions above, the amount of *free H–ion* is greater in the hydrochloric acid solution than in the boric acid solution. It thus becomes necessary to have some means of expressing the *strength* of an acid as well as its concentration.

Since strength of acid is dependent upon the free H–ion in solution, it is necessary to have some means of measuring the free H–ions in solution (*i.e.*, the degree of acidity of a solution, or the pH as it is now termed).

### 2. *Powers of Numbers, and Logarithms.*

Before proceeding, it is necessary to review briefly powers of numbers and also logarithms, as these enter into pH definition and application.

Consider the numbers 10, 100, 1,000 and 10,000. These can be represented:

| | | | | |
|---|---|---|---|---|
| 10 | = | 10 | = | $10$ |
| 100 | = | 10 x 10 | = | $10^2$ |
| 1,000 | = | 10 x 10 x 10 | = | $10^3$ |
| 10,000 | = | 10 x 10 x 10 x 10 | = | $10^4$ |

It will be seen that each number is represented in three different ways, the last column showing them as powers of the base 10. The small figure by the top of the 10 is the power, and shows how many times the base (10) must be multiplied by itself to give the required number. Thus, 1,000 is equal to $10^3$ (*i.e.* ten to the third power) which means 10 x 10 x 10, NOT 10 x 3.

The above method of expressing numbers—as powers of a given base—is purely one of convenience, as is used to simplify mathematical manipulations. Whilst any number could be used as the base, numbers are conveniently referred to the base 10.

Negative powers (or indeces) are used to represent the reciprocals of numbers. Thus:—

$$\frac{1}{1000} = \frac{1}{10 \times 10 \times 10} = \frac{1}{10^3} = 10^{-3}$$

$$\frac{1}{1{,}000{,}000} = \frac{1}{10^6} = 10^{-6}$$

These powers (both negative and positive) are also termed the logarithms to a given base (here 10.) Thus:—

$$1{,}000 = 10^3 \quad \text{and} \quad \log_{10} 1{,}000 = 3$$

and

$$\frac{1}{1{,}000} = 10^{-3} \quad \text{and} \quad \log_{10} 10^{-3} = -3$$

Numbers such as 100, 1,000 and 10,000 can easily be expressed as powers of 10 (since they are exact powers of 10) but to express other numbers (which are not exact powers of 10) as powers of 10, recourse must be had to logarithm tables. These are simply tables obtained by working out, to a definite number of decimal places, the powers of 10 which represent numbers from 10 to 99.99, the results being tabulated for easy access. It is thus possible, within the limits of the logarithm tables, to ob-

tain the logarithm to the base ten of any number or, conversely, knowing the logarithm, to determine the number.

Recourse to logarithm tables is not necessary in pH work unless the actual concentration of H–ions (in grs./L) is required. The main thing to be remembered is the meaning of the term, "logarithm to the base ten".

## *II. Hydrogen Electrode and p H*

### 1. *The Hydrogen Electrode.*

In the first section it was pointed out that it is necessary to be able to measure the H–ion concentration in order to be able to give the degree of acidity of a solution. Some measurable phenomenon, dependent upon H–ion concentration, must therefore be found. These requirements are met by the so-called Hydrogen Electrode.

When hydrogen gas at 1 atmosphere pressure is bubbled around a platinised platinum* wire or sheet which dips into a solution containing H–ions, it is found that a steady potential is produced in a few minutes, and that this potential varies with the acidity of the solution. It can be shown, by physico-chemical reasoning, that the potential $E_h$ given by such an electrode may be represented by the equation:—

$$E_h = E_o + \frac{R.\,T.}{nF} \log (H^+)$$

where E = the normal hydrogen potential, *i.e.* the potential of a hydrogen electrode in equilibrium with hydrogen gas at 1 atmosphere pressure, and also in equilibrium with a hypothetical solution containing 1 gr. –ion of H–ions per litre.

R, n and F are physical constants
T = Absolute temperature
and $(H^+)$ = H–ion concentration.

In the absence of an absolute zero of potential against which the potentials of "half elements" such as the hydrogen electrode can be measured, the *normal* hydrogen electrode potential is taken as the standard, and arbitrarily given the value of zero.

*i. e. bright platinum over which a layer of platinum black has been deposited.

Since, by convention, $E_o$ for hydrogen is zero, the above expression becomes:

$$E_h = O + \left(\frac{2.3\ R.T}{nF}\right) \log_{10} (H^+)$$

the 2.3 being the factor required to change the so-called natural logarithms to logarithms to the base 10.

Substituting the values of R, n and F, and taking T as 20°, this simplifies to:

$$E_h = 0.0581 \log_{10}(H^+)$$

that is, the potential of the hydrogen electrode varies according to the logarithm of the hydrogen ion concentration.

2. *Definition of p H*

Now, the logarithm to the base 10 of the H–ion concentration is that power of 10 which represents the H–ion concentration (see section on Logarithms). For example: suppose the H–ion concentration of a solution is 0.01 gr.–ions per litre, that is, $\frac{1}{100}$ or $10^{-2}$ Gr. ions per litre. Then $\log_{10}(H^+) = \log_{10} 10^{-2} = -2$

In general, if $(H^+) = 10^{-p}$, then $\log_{10} (H^+) = -p$

It was this power (in the mathematical meaning) of the hydrogenion concentration which Sorensen termed "pH", defining pH as minus the logarithm of the H–ion concentration,

$$i.e.\ \ pH = \log_{10} (H^+)$$

the minus sign causing positive numbers to be given for pH values since $\log_{10}(H^+)$ for ordinary solutions is a negative value.

Thus, in the above solution where $(H^+) = 10^{-2}$ the pH is:

$$pH = -\log_{10}(H^+) = -\log_{10}(10^{-2}) = -(-2) = 2$$

$$i.e.\ pH = 2$$

Hence, pH is simply a convenient method of expressing the H–ion concentration of solutions. Instead of having to say the H–ion concentration of a given solution is $\frac{1}{1{,}000{,}000}$ gr.–ions per litre, or $10^{-6}$ gr.–ions per litre, it can be stated that the pH of that solution is 6 which, as will be seen from the derivation and meaning of the term pH, is saying exactly the same thing in a shorter manner.

3. *pH Values.*

It is possible to show, theoretically, that the H–ion concentration of pure water is equal to $10^{-7}$ gr.–ions per litre, so that the pH of water = 7. Further, it can be shown that the H–ion concentrations of solutions lie between $10^{0}$ and $10^{-14}$ (the figure 14 being derived from the value of the ionisation constant for water) so that pH values for solutions lie between pH = O and pH = 14.

Since pure water is perfectly neutral, a pH of 7 represents a neutral solution, *i.e.*, a solution which is neither acid nor alkaline. A solution whose pH = 3 has a H–ion concentration of $10^{-3}$ which is greater than $10^{-7}$ (since $10^{-3} = \frac{1}{10^{3}} = \frac{1}{1,000}$ and $10^{-7} = \frac{1}{10^{-7}} = \frac{1}{1,000,000}$) so that such a solution has more H–ions per liter, *i.e.*, is more acid, than a neutral solution.

Solutions whose pH values are between 0 and 7.0 are, therefore, acid solutions. Similar reasoning will show that solutions whose pH values are between 7.0 and 14 are alkaline solutions.

## *III. Potentials and Potentiometer Measurements*

1. *Potential Measurements.*

It will be seen, from what has already been said, that by measuring the potential of a hydrogen electrode dipping into a solution, the H–ion concentration (or pH) of the solution can be determined, since (for 20°) —

$$E_h = 0.0581 \log_{10} (H^+)$$

or $$E_h = - 0.0581 \text{ pH}$$

Such potentials can not, however, be measured by themselves; they must be combined with another electrode—a standard electrode, the potential of which is known—and the total potential of the combination measured. In this way the potential of the hydrogen electrode becomes known since

$$E_m = E_h + E_s$$

where $E_m$ = measured potential; $E_h$ = potential of hydrogen electrode and $E_s$ = potential of standard electrode.

2. *Standard Reference Electrodes.*

The most commonly used standard reference electrodes are the various calomel electrodes, so named because they are made

by intimately mixing pure mercury and pure calomel (mercurous chloride, $H_gC1$) and covering the mixture with a solution of potassium chloride (KC1) of known strength. The strength of the (KC1) solution determines the e.m.f. given by the electrode. Such electrodes, when made from *pure* materials give constant and reproducible potentials at a given temperature.

The most easily made calomel electrode is the saturated calomel electrode, a saturated solution of KC1 being used in making it. In this electrode some solid KC1 is placed above the mercury paste to ensure the KC1 solution being saturated at all temperatures.

In all the calomel electrodes a platinum wire—sealed into a glass tube so that only the tip is exposed—dips into the mercury of the electrode, and this platinum wire is used to connect the electrode to the measuring device.

The potential of these standard electrodes is not affected by the solutions in which they are placed, provided none of the solution being measured finds its way into the standard electrode.

3. *Potentiometer Measurements.*

The e.m.f. of the combination (H–electrode, standard electrode) is measured by balancing it against a known potential. This measurement is made by means of a potentiometer.

The potentiometer is essentially a uniform wire of high resistance, along which there is a known fall of potential, the potential being supplied by a working cell usually a 2 volt storage battery. The exact fall of potential down the wire is determined by calibrating the wire by means of a Weston, or similar, standard cell.

The unknown potential is joined in opposition to the working potential, and by means of a sliding contact a point is found on the wire at which the two potentials exactly balance, as shown by no movement in a galvanometer which is connected in the circuit.

Knowing what fraction of the potentiometer wire is cut off by the sliding contact at the balance point, the fraction of the working potential which just balances the unknown potential is known.

Although all potentiometers are based on the above principle, modern potentiometers are designed so that the voltage at any point of the wire can be read off directly. Thus, when an un-

known e.m.f. has been balanced against a portion of the working potential it is only necessary to read off the voltage opposite a pointer, no calculations being required.

4. *Hydrogen Electrode Measurements.*

Using the equation $E_h = 0.0581 \log_{10}(H^+)$ it is possible to calculate the hydrogen electrode potential (at 20°) for any H–ion concentration (or pH). These values can then be combined with the e.m.f. of the standard half element used as reference—e.g. the saturated calomel cell, as used above—and a table made of pH values against the hydrogen electrode e.m.f. when used with the given standard electrode.

To determine the pH of an unknown solution it is then only necessary to determine the e.m.f. given by the hydrogen electrode and standard electrode together, and then refer to the appropriate tables and read off the pH value corresponding to the e.m.f. found.

To be complete, such tables should show the different voltages measured in the same solution at different temperatures. The voltage of the standard electrode, as well as that of the hydrogen electrode, varies somewhat with temperature: thus the voltage of the hydrogen electrode—standard electrode combination will vary with temperature. For accurate work the temperature must be taken into account when calculating pH; for electroplating work the effect of temperature can be disregarded and the values in the tables for 20° used entirely. This disregard of temperature will introduce an error of less than 0.05 pH even though the temperature be 5° or 40° instead of 20°.

The hydrogen electrode, requiring as it does the platinised platinum foil or wire and its supply of hydrogen gas, is not an easy electrode with which to work. Fortunately, the so-called Quinhydrone Electrode is much more convenient and easy to manipulate, and answers the same purpose as does the hydrogen electrode.

## *IV. The Quinhydrone Electrode and pH*

1. *The Quinhydrone Electrode.*

Quinhydrone is a molecular compound comprising one molecule of quinone and one of hydroquinone. When it is dissolved in water it dissociates into quinone and hydroquinone, followed by ionisation of the hydroquinone to give H–ions, an equilibrium being set up, thus:—

$$\text{Quinone} + 2H = \text{Anion of hydroquinone} + 2H^+$$

This equilibrium is sensitive to changes in the concentration of the H–ions present (*i.e.*, to changes in pH) and, further, as the equilibrium is shifted the potential given by it is changed. The potential given by the above equilibrium can be measured by placing a gold or platinum wire in the solution and combining the electrode thus made—the quinhydrone electrode—with a standard electrode and measuring the total e.m.f. with a potentiometer, just as for a hydrogen electrode.

Since quinhydrone is only very slightly soluble in water, only a few milligrammes of it are required to saturate a sufficient quantity of solution for a pH measurement. It can be added either as the solid substance (since undissolved quinhydrone does not influence the potential) or as a saturated solution of quinhydrone is acetone or alcohol.

2. *p H Measurement using the Quinhydrone Electrode.*

Using the saturated calomel cell as the standard electrode a pH determination is made as follows:

1. To a sample of the solution whose pH is to be determined add about 5 drops of a saturated solution of quinhydrone in acetone, or a little quinhydrone picked up on the end of a knife. Stir.
2. Introduce into the solution the saturated calomel electrode and the gold electrode, and connect these to the appropriate terminals of the potentiometer—which has been previously calibrated.
3. Adjust the dial of the potentiometer until, on pressing the key which completes the circuit, no deflection of the galvanometer is given.
4. As soon as a steady reading is given on the potentiometer (after about one minute) note the e.m.f. given.
5. Read off the pH corresponding to the measured e.m.f. from the E.M.F.—pH Table, using the 20° column (unless very accurate results are required.)

From this it will be seen that by means of the quinhydrone electrode pH measurements can be quickly and easily made.

3. *Advantages of the Quinhydrone Electrode.*

1. It is quick and easy. Once the manipulation has been mastered a high accuracy can be obtained with very few precautions.

2. It is also inherently accurate.
(*Note*: A study initiated at the Bureau of Standards some years ago showed the "salt error" of the quinhydrone electrode to be small. The salt error is the difference in pH of a solution when measured by the hydrogen electrode—assumed to have no salt error—and by the quinhydrone electrode, the difference in pH being due to the presence of salts, e.g., NaCl,$NiSO_4$, etc., in the solution. For some forty nickel plating solutions of total salt concentration about $2N$, the error was less than + 0.05 pH.)
3. Results do not depend on color matching—an advantage over the colorimetric method of pH determination.
4. It can be applied in colored solutions (e.g. Nickel plating solutions) and in turbid solutions.
5. There is practically no cost of upkeep, the cost of the required quinhydrone being practically negligible.
6. The same electrode and potentiometer cover a wide range of pH, from 0 to 9 pH.

4. *Limitations of the Quinhydrone Electrode.*

1. It can not be applied in solutions more alkaline than 9 pH.
2. In some solutions the potential will drift and not make reproducible values owing to the action of the solution on the quinhydrone equilibrium.
3. It can not be applied to strongly oxidising or reducing solutions.
4. The initial cost is higher than for the required materials for the colorimetric method of pH determination. This, however, is offset over a period of time by the lower cost of upkeep.

### *V. Automatic Recording and Controlling of p H*

1. *Continuous Recording of p H.*

The electrometric determination of pH, since it depends on potentials, can be applied to the continuous recording of pH. The potential given by the quinhydrone electrode (or hydrogen electrode) can be automatically balanced by a potentiometer and the pH corresponding to the balanced e.m.f. at any instant recorded on a chart, as is done by the Leeds and Northrup Recording Potentiometer. In this recorder, deflections of the galvanometer, due to unbalanced e.m.f.s., are utilized to cause adjustment of the potentiometer until a balance is reached. By

suitably calibrating the instrument, the record can be obtained directly in terms of pH.

For the continuous recording of pH by means of the quinhydrone electrode it is necessary to by-pass a certain amount of the liquid whose pH is to be measured. This solution is mixed with a quinhydrone solution in a suitable flow-channel in which is situated the gold electrode and also the standard calomel electrode. The mixed solution is circulated past the two electrodes, and the e.m.f. produced transmitted to the recorder and recorded as pH. After passing through the flow-channel, the liquid runs to waste.

The continuous recording of pH can be applied to nickel-plating solutions, and has been done (Barbaudy, Guerillot, Manchon and Simon, Compte Rendus, *192*, 739–41) (1931). In such an application the advantages gained by a continuous record of the pH solution during operation must be balanced against the value of solution lost in obtaining the results.

There is the probability of electrodes other than the quinhydrone electrode being used for pH measurements, e.g., metal electrodes, which could be placed directly in the nickel plating solution and used for the continuous recording of pH without the waste attendant upon the quinhydrone method. If such a metal electrode were used, care would have to be taken that it did not dissolve appreciably in the nickel-plating solution, or affect the nickel deposits obtained.

2. *Automatic Control of p H.*

It is possible to modify the Leeds and Northrop Recorder so that when the pH goes outside a certain pre-determined range, apparatus is set in motion to add either acid or alkali to the solution, whichever is required. The additions are automatically stopped when the pH re-enters the desired range. The advantages of such automatic control of pH in securing consistency of results over long periods of time, particularly where large volumes of plating solutions are employed, are apparent.

The automatic control of the pH of plating solutions, or even the continuous recording of the pH of plating solutions, may be in the realms of the future, but as production increases and the size of automatic plating installations increases, closer control over solution pH will be required. The electrometric method of pH determination is eminently suited to these purposes.

# FREE CYANIDE IN BRASS PLATING BATHS

By L. C. Pan*

Read at the Philadelphia Convention, 1932

The importance of controlling free cyanide in any cyanide bath for electroplating is well known. Anode and cathode efficiency, texture and quality of deposit, anode polarization, conductivity of solution and throwing power, are all affected by either too little or too much free cyanide. In brass plating, the concentration of free cyanide and its control is more important than elsewhere, on account of it being a process to deposit two metals simultaneously at a fixed ratio. Any change in free cyanide content changes the ratio of copper and zinc in the plating and also changes the color of deposit. Once having a standard set for brass plating, such changes in composition and color of deposit are most disastrous.

In addition to the serious effects of any change in free cyanide content, electroplaters are further confronted by the constant loss of free cyanide due to decomposition by heat, air and poor anode efficiency. Additions of metal cyanide if not properly balanced by equivalent amounts of sodium cyanide, would upset the free cyanide content of the bath.

With all these factors affecting free cyanide content in one way or the other, it is imperative that free cyanide should be checked by chemical analysis as often as once a day. The chemical analysis of free cyanide in other plating solutions is a simple matter and checks readily with theoretical values computed from the amounts of chemicals taken to make up the bath. Not so with brass plating solution. First, we had difficulties in getting an accurate volumetric method for free cyanide uninterfered by other ingredients and impurities of the brass plating bath. Secondly, we could not make the analytical results check with theoretical free cyanide content, based on the assumption that it takes 2 mols of sodium cyanide to combine with 1 mol of copper cyanide to form the complex copper cyanide $Na_2Cu(CN)_3$, and another 2 mols of sodium cyanide to combine with 1 mol of zinc cyanide to form the complex zinc cyanide $Na_2Zn(CN)_4$ [1]. To all indications, the complex cyanides are not likely

*Instructor in Electroplating, the College of the City of New York; Technical Director, United States Research Corp., Long Island City, New York.

[1] W. Blum and G. B. Hogaboom PRINCIPLES OF ELECTROPLATING (McGraw-Hill P. 384) (1930)

all in the latter forms. But then in what forms do complex cyanides exist in a brass solution?

The most common forms of copper and zinc complex cyanides are:

$$NaCu\ (CN)_2$$
$$Na_2Cu\ (CN)_3$$
$$Na\ Zn\ (CN)_3$$
$$Na_2Zn\ (CN)_4$$

In a brass solution, there may be present all of the four forms, or may be any two or three of them. The present work, as described below, is to determine just which complex cyanides are actually in the brass solution of the standard type as well as of any type.

The first series of experiments to determine the complex cyanides in brass solution was made on five different solutions of the following composition; these were made of pure and dry chemicals:

| | *g/1.* | *oz./gal.* |
|---|---|---|
| Copper cyanide | 31.5 | 4.2 |
| Zinc cyanide | 11.5 | 1.5 |
| Sodium carbonate | 30. | 4.0 |
| Sodium cyanide | 42–46–50.5–55–65 | 5.6–6.1–6.7–7.3–8.7 |

### *Four Methods of Analysis Used*

Due to the lack of a standard method of analyzing for free cyanide in brass plating solution, four different methods (or two methods and two modifications) were investigated. They are as follows:

(1) Titration against 0.0542 mol copper sulfate.

(2) Titration against 0.1005 normal silver nitrate with no indicator.

(3) Titration against 0.1005 normal silver nitrate with 0.18 g. potassium iodide as indicator.

(4) Titration against 0.1005 normal silver nitrate with 4.3 g. potassium iodide as indicator.

All titrations in the above four methods of analysis were made on 10 ml. of the brass solution. Enough water was added to each so that the final volume of the mixture, including indicator and standard re-agent, was 70 ml. in all cases. This is done to avoid any possible error due to dilution.

All the experimental brass solutions contain 30 g. of sodium carbonate $Na_2CO_3$ per litre. The presence of sodium carbonate

had been reported to interfere with the titration of free cyanide against silver nitrate re-agent. [2], [3]. Such interference, however, was not observed in the present study to any appreciable amount. Therefore, there could not be any error in analysis on that account.

*Titration of Free Cyanide Against Copper Sulfate*

The analysis of free cyanide with copper sulfate as standard re-agent is based on the following reaction:

$$2Cu\ SO_4 + 6NaCn + H_2O \text{ — } NaCu(CN)_2 + Na_2Cu(CN)_3 + 2NaHSO_4 + NaCNO$$

Thus, one mol of copper sulfate is equivalent to 3 mols of sodium cyanide. The copper sulfate solution used was 0.05415 M, or 0.1625 N with respect to free cyanide. It was standardized against metallic copper through sodium thiosulfate as an intermediate step. Its strength was checked against c.p. sodium cyanide. With this standard copper sulfate, the free cyanide contents of the above five brass solutions were determined. The results were plotted against the total sodium cyanide present in the solutions (Fig. 1). On the same coordinates are also plotted hypothetical values of free cyanide calculated from four different combinations of the complex cyanides of copper and zinc:

$NaCu(CN)_2$.....$NaZn(CN)_3$, designated as 1—1*
$NaCu(CN)_2$.....$Na_2Zn(CN)_4$, designated as 1—2*
$Na_2Cu(CN)_3$.....$Na_2Zn(CN)_3$, designated as 2—1*
$Na_2Cu(CN)_3$.....$NaZn(CN)_4$, designated as 2—2*

Comparing the relative positions the actual and hypothetical values of free cyanide, we could determine which of the above four combinations exist in the brass solution and what effect free cyanide has of shifting one combination to another. In the present case, it may be noted that when free cyanide is low, the combination is very close to 2—1; but when the free cyanide is high it is approximately 2—1.5. This indicates the possibility of presence of both $NaZn(CN)_3$ and $Na_2Zn(CN)_4$, with $NaZn(CN)_3$ prevailing in normal brass solutions. In preparing a brass solution, therefore, it is incorrect to assume that the complexes are $Na_2Cu(CN)_3$ and $Na_2Zn(CN)_4$.

[2] G. B. Hogaboom, "Brass Plating", Souvenir Year Book by Philadelphia Branch of American Electroplater's Society, 58-76 (1929)
[3] E. B. Sanigar, "The Titration of Potassium Cyanide and Free Cyanide in Silver Plating Solutions", Trans. Electrochemical Society, 58, 435 (1930).

* These numbers represent the number of mols of sodium cyanide attached to each mol of copper and zinc cyanide, respectively, to form the complex cyanides.

*Titration of Free Cyanide Against Silver Nitrate*

To check the above view that a normal brass plating solution contains mostly $Na_2Cu(CN)_3$ and $NaZn(CN)_3$ exclusive of $NaCu(CN)_2$ and possibly of $Na_2Zn(CN)_4$, the same brass solutions were again analyzed this time with silver nitrate as standard re-agent. The results obtained are surprisingly close to the theoretical values based on $Na_2Cu(CN)_3$—$NaZn(CN)_3$, throughout the entire range of free cyanide from 1. to 25 g./L. (Fig. 2). This was again checked by two more series of titrations of the same solutions against silver nitrate with two concentrations of potassium iodide as indicator, one 0.0157 N (0.18 g.) and the other 0.37 N (4.3 g.) respectively in the titration mixture which had a total volume of 70 ml. in all cases. Both series of titrations give results close to the theoretical values of free cyanide calculated on basis of $Na_2Cu(CN)_3$—$NaZn(CN)_3$. A glance at the points plotted in Fig. 2 excludes all doubt regarding the form of complex cyanides in brass plating solutions at all concentrations of free cyanide.

*Brass Solutions With Various Cu—Zn Ratios*

The above experiments still leave a possibility of presence of $NaCu(CN)_2$ and $Na_2Zn(CN)_4$ in the brass solution, as, by referring to Fig. 1 and 2, the line 1—2 is parallel to line 2—2 and a certain combination of the two would give results falling on line 2—1. To clear up this point, another series of brass solutions were prepared in which the copper-to-zinc ratio varies from 10.1 down to 1.84.

The composition of this series of brass solutions are given under Fig. 3. The formulae were so balanced that they all have the same amount of free cyanide, assuming the combination $Na_2Cu(CN)_3$—$NaZn(CN)_3$ is correct and holds for all Cu—Zn ratios.

Each solution was analyzed for free cyanide against 0.1005 N. Silver nitrate with and without potassium iodide as indicator in three different ways. The results are plotted in Fig. 3, along with hypothetical values for free cyanide based on four different combinations of the complex cyanides as before. Since all solutions contain the same amount of copper cyanide the free cyanide is plotted against zinc cyanide instead of Cu—Zn ratios. The net results are the same.

It may be noted from Fig. 3 that with the exception of two points, all the results of titration fall almost exactly on the line 2—1. In other words, the experimental results, with varying Cu—Zn ratios, again point to the presence in the brass solutions of $Na_2Cu(CN)_3$ and $NaZn(CN)_3$ and these two only. This time, there is no doubt nor possibility of the presence of either $NaCu(CN)_2$ or $Na_2Zn(CN)_4$, because the lines for the different combinations of complexes do not run parallel.

*Conclusions*

1. After having checked the free cyanide of the brass solution from the three different angles and by four different analytical methods, and when results so obtained all point to one conclusion, there is hardly any doubt but that the complexes in the brass plating solutions are $Na_2Cu(CN)_3$ and $NaZn(CN)_3$ instead of $Na_2Zn(CN)_4$. Any brass solution prepared on the basis of $Na^2Zn(CN)^4$ will have too high free cyanide.

Fig. 1. Free cyanide in Brass Plating Baths, Calculated and Determined by Titration Against 0.0542 M. $CuSO_4$.

Fig. 2. Free Cyanide in Brass Plating Baths, Calculated and Determined by Titration Against 0.1005 N.$AgNO_3$ With and Without KI Indicator.
(Final volume of titration mixture = 70 ml. in all cases).

*Figure* 1

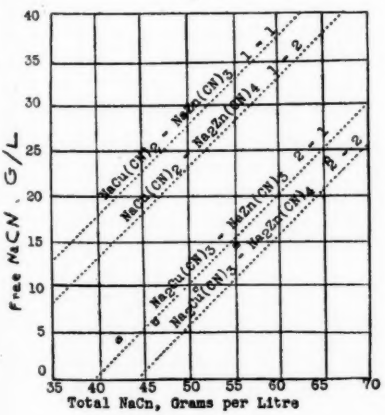



*Figure* 2

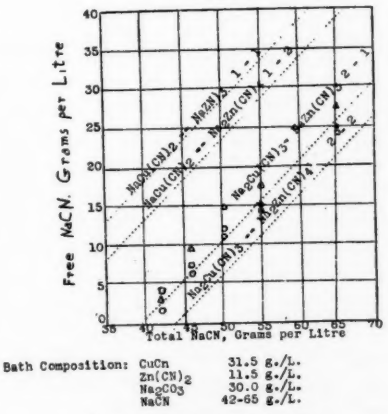
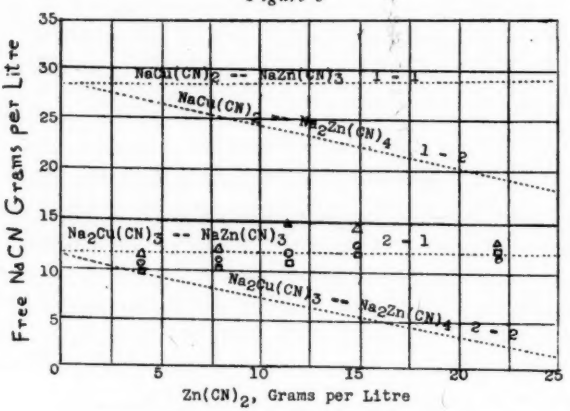

Free NaCN, Grams per Litre
Total NaCN, Grams per Litre
Bath Compositions: CuCn 31.5 g./L.
Zn(CN)2 11.5 g./L.
Na2CO3 30.0 g./L.
NaCN 42-65 g./L.
Δ - 0.0157 N. KI in Mixture
□ - 0.37 N. KI in Mixture
○ - No Indicator

Fig. 3. Free Cyanide in Brass Plating Baths, Calculated and determined by Titration Against 0.1005 N. $AgNO_3$, With and Without KI Indicator.

*Figure 3*




Final Volume of Titration Mixture = 70 ml.
△ -- 0.0157 N. KI in Mixture as Indicator
□ -- 0.37 N. KI in Mixture as Indicator
○ -- No Indicator

| Bath Composition: | | |
|---|---|---|
| CuCn | 31.5 | g./L. |
| $Zn(CN)_2$ | 11.5 | " |
| $Na_2CO_3$ | 30.00 | " |
| NaCN | 42—65 | " |

Final volume of Titration mixture = 70 ml.

Bath Compositions:

| | I. | II. | III. | IV. | V. |
|---|---|---|---|---|---|
| CuCN | 31.5 g./L. | 31.5 g./L. | 31.5 g./L. | 31.5 g./L. | 31.5 g./L. |
| $Zn(CN)_2$ | 4.0 " | 8.0 " | 11.5 " | 15.0 " | 22.0 " |
| Na CN | 47.5 " | 49.5 " | 50.5 " | 52.5 " | 55.5 " |
| $Na_2CO_3$ | 30.0 " | 30.0 " | 30.0 " | 30.0 " | 30.0 " |

# BRANCH NEWS

## CLEVELAND BRANCH

The following Officers were elected for the years 1933 and 1934: President, Mr. H. J. Ter Doest; Vice-President, Mr. B. F. McCormick; Secretary-Treasurer, Mr. W. D. Scott; Librarian, Mr. E. Steen Thompson. Board of Managers, Mr. J. C. Singler, Mr. H. A. Weber, Mr. Elmer Peterjohn. Auditors of Books, Mr. P. R. Lyons, Mr. H. J. Ter Doest. Delegates to Convention, Mr. E. Steen Thompson, Mr. J. C. Singler, Mr. H. J. Ter Doest; Alternates, Mr. Elmer Peterjohn, Mr. O'Berg.

## HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch held its regular monthly meeting on Monday evening, May 22, 1933, at the Hartford Chamber of Commerce.

The meeting was called to order at 8.30 P. M. with President Fleming in the chair. Minutes of the previous meeting were read and accepted. All bills were voted paid. All communications were read and placed on file. Mr. W. E. Bancroft, of the Pratt & Whitney Co. of Hartford, was elected as an Active member. There was no speaker for the evening.

Because of no communication from our Supreme President, in regard to our petition to dissolve the present branch, and make petition for the forming of a new one in Hartford, the same officers were retained in the chairs until some definite word is received from the Supreme Society in regard to our petition.

Delegates to the National Convention were elected as follows: Mr. W. J. R. Kennedy, Edward Fleming, Vernon E. Grant; Alternates, W. E. Seidel, Jos. Beloin, Geo. Vibberts.

The meeting was attended by only ten members and was adjourned at 10.00 P. M.

V. E. GRANT, *Secretary.*

## LOS ANGELES BRANCH

In March, instead of holding our regular meeting we held an open meeting, or smoker, devoted entirely to entertainment. No business was transacted.

At the February meeting the Branch voted not to put in a bid for the National Convention in 1934. We feel that we are too far from the majority of the membership of the society to make it practical for us to try to hold the Convention here until financial conditions throughout the country have improved. We are hoping that this will not be later than 1935.

EARL COFFIN, *Secretary.*

## NEWARK BRANCH

The regular meeting of the Newark Branch was held Friday evening, June 3rd, and the following Officers were installed for the year by Past President Mr. Sievering: President, Mr. Paul Oldam; Vice-President, Mr. Samuel Taylor; Secretary-Treasurer, Mr. George Reuter; Librarian, Mr. Bert Sage; Sergeant-at-Arms, Mr. George Klink; Trustees, Mr. Wagner, Mr. Wodeckin,

Mr. Harrison; Delegates, Mr. Sievering, Mr. Sizelove, Mr. Smith; Alternates, Mr. Aodeclen, Mr. Oldam, Mr. Harrison.

After which a ways and means for helping boost the Research Fund was discussed.

Applications of Mr. Ecklemenn, Mr. Dolgin, Mr. J. Hedrichs, Mr. D. Morglin were ordered to take regular course.

Our Librarian, Mr. Sage gave a splendid talk on Nickel and Mr. George Hogaboom spoke on Chemistry and What is it!

GEORGE REUTER, *Secretary.*

## MILWAUKEE BRANCH

On Thursday, June 8, 1933, Milwaukee Branch held its annual meeting with a good attendance, this was a double jollification meeting. Milwaukee Branch since the bank moratorium has been in the red. At this meeting it was reported that our Branch has met all its obligations, and again had a few dollars cash on hand. The old timers, some that had not attended the meetings for some time, were on hand to attend the installation of officers, and to partake of the refreshments that we had not been able to serve our boys, on account of our former finances. The Board of Managers were complimented for bringing us out of the red. It was due to their efforts that we had cut all expenses, and made a drive to collect dues from delinquents. Dexter F. Rhodes an old friend of the Branch was elected to membership and initiated. One of the most pleasant surprises, was the announcement that our Secretary-Treasurer, Frank J. Marx, had donated his salary for the past year to the general fund, without this contribution Milwaukee Branch would still be in the red. Frank, one of our regular workers was given a vote of thanks by the whole assembly.

The new officers were then installed. Pat Sheehan was Master of Ceremony, and that meant a short but well done job. After the installation the new officers took their respective positions.

President, Paul Krause; Vice-President, Robert Shaffer; Secretary-Treasurer, Frank J. Marx; Librarian, Henry Binder; Assistant Librarian, Edw. Werner, and the veteran's: Bob Stenernagel, Dan Wittig and Jack Geissman, Board of Managers.

The next order of business was the instruction of members elected as delegates to the Chicago Convention.

Delegates, Robt. W. Shaffer, Paul Krause, Jos. Bykowski. Alternates, Pat Sheehan, Edw. Werner, Frank J. Marx were with us, there were new faces in the list of delegates. Some of the former veteran delegates thought it best that some of the new members get acquainted with the work of the Convention. Milwaukee Branch will be well represented. Some of the members will not take in all of the meeting, but have picked the days that were of most interest.

The meeting adjourned. The refreshments and plenty of 3.2 were then the object of attack, the spirit of good fellowship took its place again. The meeting adjourned at 11 P. M. when the 3.2 gave out. The Lunch and Refreshments were donated by the Board of Managers.

## WATERBURY BRANCH

The annual election of Waterbury Branch which took place Friday, May 12th, resulted in the election of the following Officers: President, Tennant Elwin; Vice-President, Wm. Cavanaugh; Secretary-Treasurer, Wm. F. Guilfoile; Librarian, Charles Nardozze; Assistant Librarian, Ellsworth Candee; Board of Managers, Wm. J. Gray, Richard Crane, Septinnes Marland; Delegates to Supreme Convention, Wm. F. Guilfoile, Wm. J. Gray and Wm. Delage; Alternates, Andrew Perrin, Septinnes Marland and Joseph McConas. The following Committee was appointed to arrange for the annual entertainment which took place Friday evening, May 26th, at the office of the Lea Co., Earl Couch, Wm. Cavanaugh, Wm. Gray, Richard Crane and Ralph Lee. Delegations from the Bridgeport and Hartford Branches were present. At a recent meeting, W. J. R. Kennedy, Editor, gave an interesting address on the publishing and editing of the Review. During the course of the speakers remarks, some very good suggestions and recommendations were made relative to changing the policy of the Review.

After the address of the editor, the consensus of opinion amongst those present seemed to be, that if the coming convention adopted the ideas of the editor and others of a similar mind, it would prove to be a wise move for the Society.

W. F. GUILFOILE, *Secretary.*

## BRIDGEPORT BRANCH

The April meeting of the Bridgeport Branch of American Electro-Platers' was held on the first Friday of the month in the Chamber of Commerce Rooms in the Stratfield Hotel at 8.30 P. M. In the absence of the President, George Wagstaff, Vice-President, Al. Rosenthal called the meeting to order.

The minutes were read and accepted.

The Sick Committee reported Phil Willett, recovering from a recent illness, and John Maher who has been laid up in Stamford Hospital.

Employment applications from Mr. Gilbertson and communications from Mr. C. Thompson were read and ordered placed on file.

There were no bills, or unfinished business—meeting adjourned at 9.45.

On May 5 at 8.45 P. M. in the Chamber of Commerce rooms of the Stratfield Hotel the Bridgeport Branch held its monthly meeting.

The Sick Committee was the only one to make a report, and informed all that John Maher was improving in Stamford.

Delegates to the Convention were instructed to carry out the contents of the communication from Mr. C. Van Derau. Communication from Mr. E. Thompson's were read and ordered placed on file.

There were no applications on balloting for membership.

Suspensions: Frank Townsend, Henry Wagner.

Elections for coming year: Albert Rosenthal, President; Herman Brown, Vice-President; William Flaherty, Secretary-Treasurer; John Schneider, Librarian; John Barry, Sergeant-at-Arms; William Stratton, William Thompson, John Obrender, Board of Managers; Joseph Sexton, Thomas Brosmon, Raymond O'Connor, Delegates to Convention; Arthur Seefahrt, Thomas Chamberlain, Phillip Willett, Alternates.

A motion was made and seconded that all bills be signed and paid.

Treasurer's report was read and accepted.

The books of the Branch were audited by the Board of Managers and were O.K.

Motion made to adjourn at 10.00 P. M.

On June 2nd, the monthly meeting of the Bridgeport Branch was held in the Chamber of Commerce rooms in the Stratfield Hotel. President Al. Rosenthal called the meeting at 8.45 P. M.

The minutes of the previous meeting were read and accepted.

The committee for the installation reported that the matter would be considered at the next meeting.

The Sick Committee reported that John Maher is still in Stamford Hospital. The boys wish him a speedy recovery.

Delegates were instructed to use their own judgment at the coming Convention.

The Sick Committee for the following year will consist of: Ben Kusterer, Herman Brown, Arthur Seefahrt.

Treasurer's report was read and accepted. No bills. Meeting adjourned at 10 P. M.

WM. H. FLAHERTY, *Secretary.*

## ANDERSON BRANCH

The regular monthly meeting of the Anderson Branch was held Friday evening, April 7th at the Guide Lamp Club. The program committee decided to have this meeting out at the club with a dutch lunch and pep session for the coming banquet.

The members gathered about 6 P. M. enjoyed a very fine lunch and the business meeting opened at 7.30.

Roll call of officers showed Mr. Guy Cole absent.

Minutes of the previous meeting read and approved. Letter received from Mr. Gilbertson relative to employment blanks. Secretary was instructed to report that all members are employed.

Letter from Newark Branch relative to their Educational Session Gala Show and Dance read. Secretary instructed to write a letter of thanks to the Branch for their invitation.

Letter from Chicago Branch read. Secretary instructed to find out registration fee.

There were no bills.

Mr. Cleaver appointed the following Banquet Committee.

General Chairman, Geo. S. Cole.

Hotel Arrangements—Chairman, Mr. E. A. Kaegi, Mr. Guy Cheney, Mr. Roy Shockley.

Music Committee—Chairman, Mr. D. A. Cotton, Mr. Fred Hammond.

Program and Speaker Committee—Chairman, Mr. Guy Cole, Mr. Wm. Castell, Mr. R. M. Wagner.

Ticket Committee—Chairman, Mr. James Minton, Mr. Ralph Seabury, Mr. H. Staggenburg, Mr. C. H. Bonge, Mr. Fletcher, Mr. Chester Wilson.

Entertainment Committee—Chairman, Mr. Geo. Onksen, Mr. Jess Wilson, Mr. Ward Taylor.

Moved and passed that Banquet be held at an uptown hotel on May 20th, 1933.

Moved and passed that tickets cost $1.25 each.

Secretary instructed to inform the newspaper.

A special meeting is to be held April 17th, at the Y. M. C. A. at 7.30 P. M. to hear Dr. G. S. Clark who is connected with the Chemistry Department of the University of Illinois. Dr. Clark has written several books and is a world renowned X-ray specialist. Mr. Ralph Seabury, one of our members has made this talk possible and we are planning on having a big turnout.

G. S. Cole, *Secretary-Treasurer.*

The regular monthly meeting was held May 1st, at the Y. M. C. A., Anderson, Indiana.

President C. D. Cleaver called the meeting at 7.45 P. M. with the following officers absent—Mr. Kaegi, Mr. Guy Cole and Mr. Hammond.

Minutes of the previous meeting read and approved.

Bill to Supreme Society for membership cards presented and ordered paid.

Letters from Mr. Gilbertson, relative to the release of Mr. Glen Hutt's talk of the 6th of March, read to the Branch.

Letter read from Mr. C. Steen Thompson, Supreme Vice-President concerning the latest method of keeping an accurate record of all members.

Two applications presented—Mr. Everett Vinson as an active member and Mr. Fred Carl as an associate. Both applications accepted.

Various committee chairmen called upon to discuss the banquet situation. Ticket committee headed by Mr. James Minton reported that approximately 100 tickets had been sold. The music committee was presented with a plan whereby they might obtain talent for little or no expense to the Society. Mr. D. A. Cotton, Chairman, was to investigate.

Motion presented that the office of Secretary-Treasurer be split up into two separate offices—seconded and approved.

Motion presented that a special meeting be held May 15th, for election of officers and to listen to a talk to be presented by Mr. Fred Carl, seconded but not passed.

Motion made that special meeting be held May 15th, to hear talk to be presented by Mr. Fred Carl—seconded and passed.

Election of Officers proceeded and nominations opened: President—Messrs. Wagner, Castell, G. S. Cole—Mr. Wagner elected. Vice-President—Messrs. Seabury, Wagner, Castell, C. Wilson—Mr. Castell elected. Secretary—Messrs. G. M. Cole, Onksen, Hammond, C. Wilson—Mr. G. M. Cole elected. Treasurer—Messrs. Onksen, C. H. Bonge—Mr. Onksen elected. Librarian—Messrs. Minton, Fletcher, C. Wilson—Mr. Minton elected. Board of Managers—Messrs. Cleaver, Cheney, Cole, Cotton, Bonge, Taylor—Messrs. Cleaver, Cheney and Cole elected.

Following this, delegates and alternates to the National Convention were nominated—Messrs. Cleaver, Wagner, G. M. Cole, Kaegi, Castell, Phelps,

G. S. Cole: Delegates elected—Messrs. Cleaver, G. M. Cole and G. S. Cole. Alternates elected—Messrs. Wagner, Castell and Phelps.

Meeting adjourned at 10.00 P. M.

G. S. Cole. *Secretary-Treasurer.*

## CHICAGO BRANCH

The following Officers were elected at our May 13th meeting: President, E. G. Stenberg, 2200 N. Kenneth Ave., Vice-President, F. Herbst, 1116 Lill Ave., Secretary-Treasurer, J. W. Hanlon, 3004 N. Whipple St., Librarian, O. E. Servis, 5305 Warner Ave.

Board of Managers—Chairman, Mr. Chas. Stiers, Mr. H. E. Gilles, Mr. M. H. Longfield.

Delegates—Mr. O. E. Servis, Mr. J. Hay, Mr. H. A. Gilbertson.

Alternates—Mr. F. J. Hanlon, Mr. G. Jelinek, Mr. F. L. Greenwald.

## APPLICATIONS

FRED W. CARL, 216 W. 14th St., Anderson, Ind. (Assoc.).....Anderson
EVERETT VINSON, 813 Indiana Ave., Anderson, Ind.....Anderson
A. BRENNER, 1790 Lanier Pl., Washington, D. C.....Balto.-Wash.
W. T. BROMWELL, 60 Bellaire Ave., Clarendon, Va.....Balto.-Wash.
H. H. FRANCISCO, Box 311-A, R.F.D. No. 3, Dundalk, Md.....Balto.-Wash.
GEO. BROWN, JR., c/o B. F. Sturtevant Co., Hyde Pk., Mass.....Boston
C. M. CAMPBELL, Crane Co., 4100 S. Kedzie Ave., Chicago, Ill., (Assoc.) Chicago
F. J. KAIN, Union Brass & Metal Mfg. Co., St. Paul, Minn. (Assoc.)....Chicago
H. THOMSEN, 2806 Altgeld St., Chicago, Ill.....Chicago
JAMES CABALEK, 2574 E. 128th St., Cleveland, Ohio.....Cleveland
W. E. BANCROFT, Pratt & Whitney Co., Capitol Ave., Hartford.....Hartford
JOHN STEGEMAN, 3655 Sherbrooke Rd., Toledo, Ohio.....Toledo
JAMES GERITY, 10 South Superior St., Toledo, Ohio.....Toledo
GEO. M. MILLSPAUGH, Box 127, Thomaston, Conn.....Waterbury
R. E. JACKSON, 2422 North Mutter St., Philadelphia, Pa.....Philadelphia

## ELECTIONS

FRED W. CARL, 216 W. 14th St., Anderson, Ind.....Anderson
EVERETT VINSON, 813 Indiana Ave., Anderson, Ind.....Anderson
GEO. BROWN, JR., c/o B. F. Sturtevant Co., Hyde Pk., Mass.....Boston
C. M. CAMPBELL, Crane Co., 4100 S. Kedzie Ave., Chicago, Ill.....Chicago
JAMES CABALEK, 2574 E. 128th St., Cleveland, Ohio.....Cleveland
W. E. BANCROFT, Pratt & Whitney Co., Capitol Ave., Hartford.....Hartford
JOHN STEGEMAN, 3655 Sherbrooke Rd., Toledo, Ohio.....Toledo
JAMES GERITY, 10 South Superior St., Toledo, Ohio.....Toledo
GEO. M. MILLSPAUGH, Box 127, Thomaston, Conn.....Waterbury

## TRANSFER

J. G. Sterling from Chicago Branch to.....Bridgeport

## REINSTATEMENT

John Van Daff, 611 Maple St., Kalamazoo, Mich.....Grand Rapids

## CHANGE OF MEMBERSHIP

C. E. Clindinin from associate membership to active membership....Chicago

## RESIGNATIONS

*St. Louis.* E. S. Weil. *Detroit.* E. R. Fahy. *Chicago.* F. J. Reinker. *Baltimore-Washington.* Geo. Doersch. *Los Angeles.* O. M. Worthington. *Toronto.* V. D. Nash, B. Deakin.

## DEATHS

J. Holzinger.....Hartford
C. A. Baker, member of former Indianapolis Branch
James Emmett.....Los Angeles

## SUSPENSIONS

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Meets first Monday of every month at 7.30 p. m. at the Anderson, Indiana, Y. M. C. A. Secretary, G. M. Cole, 104 Beverly Terrace, Anderson, Indiana.

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Meets first and third Fridays of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary-Treasurer, Wm. H. Flaherty, 642 Beechwood Ave., Bridgeport, Conn.

### CHICAGO

Meets second Saturday of each month, at 8 p. m., Atlantic Hotel, 316 S. Clark St., Secretary, James Hanlon, 3004 N. Whipple St., Chicago, Illinois.

### CINCINNATI

Meets every Thursday, 7.30 p. m., at Vocational Training School, Spring and Liberty Sts. Secretary, Al. Yeager, 2021 Sherman Ave., Norwood, Ohio.

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Meets fourth Monday in each month alternately at the Chamber of Commerce, 815 Main St., Hartford, and the Chamber of Commerce, 134 Chestnut St., Springfield. Secretary, Vernon Grant, 32 Jennings Road, Bristol, Conn.

### LOS ANGELES

Meets second Wednesday of each month at 6.30 p. m., at the Rosslyn Hotel, 2nd floor, N. W. Cor. of 5th and Main Sts. Secretary, Earl Coffin, 2910 S. San Pedro St., Los Angeles.

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Meets second Thursday of each month at Cor. 3rd and Highland Ave. Secretary, Frank J. Marx, 1431 W. Cherry St., Milwaukee, Wis.

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Meets second and fourth Friday of each month, at 1437 Aylmer St., Montreal, Quebec, Canada, where the Secretary-Treasurer, Mr. Charles Doherty, can be found at any time.

### NEWARK

Meets first and third Fridays of each month, at Newark Elk's Club, Broad St., Newark, N. J., at 8 p. m. Secretary-Treasurer, Geo. Reuter, P. O. Box 201, Newark, N. J.

### NEW YORK

Meets second and fourth Fridays of each month, in the World Building, Park Row, New York City, N. Y. Secrerary-Treasurer, J. E. Sterling, 2540 Steinway St., Astoria, L. I.

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### SAN FRANCISCO

Meets at Plaza Hotel, San Francisco. Secretary, H. W. McKibben, 310 Tehama St., San Francisco, Cal.

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